



# **ARMY NET ZERO PROVE OUT**

## **Net Zero Energy Best Practices**

**November 18, 2014**

Distribution A

Approved for public release, distribution is unlimited

Requests for this document shall be referred to:

Office of the Deputy Assistant Secretary of the Army for  
Energy and Sustainability (ODASA[E&S])  
110 Army Pentagon, Room 3D453  
Washington DC 20310-0110

Contract No. W91ZLK-10-D-0005

Task No. 0818

CDRL No. A007

*Submitted by*



*Concurrent Technologies Corporation*

*100 CTC Drive*

*Johnstown, PA 15904*

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for information operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, D.C. 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE November 18, 2014		3. REPORT TYPE AND DATES COVERED Final (5/23/13 – 11/22/2014)
4. TITLE AND SUBTITLE Net Zero Energy Best Practices			5. FUNDING NUMBERS Contract: W91ZLK-10-D-0005 Task: N.0818	
6. AUTHOR(S) Caroline Harrover, Elizabeth Keysar, Karen Downs, Arielle Wait and Heidi Kaltenhauser				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Defense Center for Energy and Environment Operated by Concurrent Technologies Corporation 100 CTC Drive Johnstown, PA 15904			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) NDCEE Program Office (Office of the Assistant Secretary of the Army for Installations and Environment) 5850 21 <sup>st</sup> Street, Building 211, Second Floor Fort Belvoir, VA 22060-5527 Program Manager: Mr. Erik Hanageland, NDCEE Program Manager, 410-306-3184			10. SPONSORING/MONITORING AGENCY REPORT NUMBER NDCEE-CR-2014-087	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Distribution A Approved for public release, distribution is unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  In support of Task No. 0818, "Army Net Zero Prove-Out," the National Defense Center for Energy and Environment (NDCEE), operated by Concurrent Technologies Corporation (CTC), was tasked to provide the Office of the Deputy Assistant Secretary of the Army for Energy & Sustainability (ODASA[E&S]) written summaries of significant, demonstrated best practices of Net Zero Energy that can be used to guide Army installations in their pursuit of Net Zero Energy and facilitate the institutionalization of Net Zero across the Army enterprise Information required to develop these Best Practices was collected over the course of this Task 818 and the NDCEE leveraged previous work with the NZ Pilot Installations under Task 0755. During the Period of Performance (POP) of T-0755 and since the commencement of this Task, monthly collaboration calls have been held between the Army Net Zero Energy Team leaders, external resources, NDCEE and the Army Net Zero Energy Pilot Installations (recently, participation has expanded beyond the pilot installations). These monthly calls accounted for the majority of Best Practices collected and were also included in the NZ Implementation Guide. The enclosed brochure found at Appendix A is intended to facilitate a comprehensive perspective for the institutionalization of NZ across the Army and aid in the transition of the NZ Pilot Installation Initiative concepts to a wider Army audience.				
14. SUBJECT TERMS			15. NUMBER OF PAGES 20	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT None	

## TABLE OF CONTENTS

	<b>Page</b>
<b>LIST OF ACRONYMS AND ABBREVIATIONS .....</b>	<b>ii</b>
<b>EXECUTIVE SUMMARY .....</b>	<b>iii</b>

## LIST OF APPENDICES

Appendix A:	Net Zero Energy Best Practices Brochure
Appendix B:	Text version of the Net Zero Energy Best Practices

## LIST OF ACRONYMS AND ABBREVIATIONS

ACOM	Army Command
ARNG	Army National Guard
CTC	Concurrent Technologies Corporation
CSP	Concentrated Solar Power
Dem/Val	Demonstration and validation
DoD	Department of Defense
DPW	Department of Public Works
DRU	Direct Reporting Unit
ECIP	Energy Conservation Investment Program
EMCS	Energy Management Control Systems
EO	Executive Order
ESCO	Energy Services Company
ESPC	Energy Savings Performance Contract
FEMP	Federal Energy Management Program
GSHP	Ground Source Heat Pump
HVAC	Heating, Ventilation and Air Conditioning
LEED	Leadership in Energy & Environmental Design
LED	Light-emitting diodes
MDMS	Meter Data Management System
MILCON	Military Construction
NDCEE	National Defense Center for Energy and Environment
NREL	National Renewable Energy Laboratory's
NZ	Net Zero
ODASA(E&S)	Office of the Deputy Assistant Secretary of the Army for Energy & Sustainability
OSD	Office of the Deputy Under Secretary of Defense
PPA	Power Purchase Agreement
RE	Renewable Energy
RMI	Republic of the Marshall Islands
RFTA	Reserve Forces Training Area
RCI	Residential Communities Initiative
SIR	Savings to Investment Ratio
SRM	Sustainment, Restoration and Modernization
UESC	Utility Energy Savings Contract
UMP	Utilities Modernization Program

## EXECUTIVE SUMMARY

In support of Task No. 0818, “Army Net Zero Prove-Out,” the National Defense Center for Energy and Environment (NDCEE), operated by Concurrent Technologies Corporation (CTC), was tasked to provide the Office of the Deputy Assistant Secretary of the Army for Energy & Sustainability (ODASA[E&S]) written summaries of significant, demonstrated best practices of Net Zero Energy that can be used to guide Army installations in their pursuit of Net Zero Energy and facilitate the institutionalization of Net Zero across the Army enterprise.

On April 19, 2011, the Assistant Secretary of the Army for Installations, Energy and Environment, the Honorable Katherine Hammack announced the sites for the Army Net Zero Pilot Installation Initiative – eight (8) installation Net Zero Energy pilots and one (1) state-wide Army National Guard (ARNG) energy pilot :

- Fort Detrick, Maryland
- Fort Hunter Liggett, California
- Sierra Army Depot, California
- Parks Reserve Forces Training Area (RFTA), California
- West Point, New York
- Kwajalein Atoll, Republic of the Marshall Islands (RMI)
- Fort Carson, Colorado
- Fort Bliss, Texas
  
- State-Wide Oregon Army National Guard (ARNG)

These sites served as test beds for the Army’s Net Zero Initiative, specifically, Net Zero Energy, and the Army provided technical support to the Pilots, by way of developing baselines, assessing energy efficiencies, energy security and renewable energy potential and developing Net Zero plans (or Roadmaps). The intent was to transition and institutionalize Net Zero concepts, responsibility, methods, and implementation activities from the pilot installations to the appropriate Army Commands (ACOMs)/Direct Reporting Units (DRUs) and all Army installations. The purpose of this task was to support that transition by documenting Net Zero Energy best practices identified that can be shared with other Army installations and advance the Net Zero concept across the Army.

Net Zero builds on longstanding sustainable practices and incorporates emerging best practices in building and community management of energy, water and solid waste at Army installations. With the 28 January 2014 issuance of the Army Net Zero Installation Directive, it became Army policy that all installations will implement Net Zero Energy to the maximum extent practical and fiscally prudent by reducing overall energy use, maximizing efficiency, implementing energy recovery and cogeneration opportunities, offsetting the remaining demand with the production of renewable energy from onsite sources so that the Net Zero energy installation produces as much renewable energy as it uses over the course of a year.

The Net Zero Energy Best Practices brochure (Appendix A) and text version for facilitating review (Appendix B) developed for this task captures significant, demonstrated best practices at

the eight (8) Net Zero Energy pilot installations and one (1) state-wide ARNG energy pilot. Previous experience from NDCEE Task 0755, ongoing collaboration calls, and Net Zero meeting support was leveraged to capture achievements of the pilot installations, identify those projects that can be replicated at other installations and help the transition of the Net Zero Pilot Installation Initiative concepts to a wider Army audience

## APPENDIX A

### Net Zero Energy Best Practices Brochure



energy\_Net Zero  
Brochure, JUNE...





# *Energy*







# Energy

Net Zero Energy involves reducing overall energy use, maximizing efficiency, implementing energy recovery and cogeneration opportunities, and then offsetting the remaining demand with the production of renewable energy from on-site sources, such that the Net Zero Energy installation produces as much renewable energy as it uses over the course of a year.

## THE ARMY'S NET ZERO INITIATIVE:

Net Zero is a strategy for sustainably managing energy, water, and solid waste programs on Army installations in a way that ensures the Army of tomorrow has the same access to energy, water, land and natural resources as today's Army. Net Zero installations will reduce energy and water usage and solid waste generation, exceeding goals set by Executive Orders, Department of Defense (DoD) Directives and Army Policies, where fiscally responsible. The journey towards Net Zero will provide greater energy and water security and increase operational flexibility.

### Introduction

To date, the Army has made substantial progress in the areas of Net Zero Energy, Water, and Waste. A number of federal mandates, rising fuel costs, over-reliance on fragile commercial power grids, aging water and wastewater distribution systems coupled with the risk of compliance penalties have challenged the Army to step up and lead by example with its Net Zero Initiative. The Army rose to this challenge with the Net Zero Pilot Installation Initiative, which has allowed the Army to identify best practices and lessons learned that can be used to guide all installations in achieving Net Zero goals. Capturing lessons learned and incorporating best practices in installation operations and management is a crucial step in institutionalizing Net Zero across the Army enterprise. This document summarizes best practices for implementing Net Zero Energy which can decrease costs, improve energy security and increase operational capabilities and resiliency. Best practices are organized into four main areas: **1)** Management Tools and Strategies; **2)** Outreach, Education and Awareness; **3)** Pilot Programs and New Technologies; and, **4)** Existing Programs and Funds. While this document is specific to energy, some of the listed best practices are programs, policies, and strategies that can also be applied to Net Zero Water and Waste, as well as integrated efforts to align Net Zero Energy, Water and Waste efforts.

### Management Tools and Strategies

Management tools include software and data systems that enable improved energy management of facilities. The tools allow energy use to be determined, monitored, and analyzed to facilitate the identification of reduction and efficiency opportunities. Management strategies are available that focus on commissioning, retrofits and ongoing activities within buildings to enable more efficient use of energy. The following lists management tools first and then strategies that have

been tried and proven as a best practice in the pursuit of Net Zero Energy (in alphabetical order):

#### Tools

**Energy Assessment Tools** – Assessment tools such as the National Renewable Energy Laboratory's (NREL) *simuwatt* can estimate energy usage with better accuracy and faster results than with a traditional on-site audit. Energy assessment tools can quickly pinpoint energy losses in order to isolate and reduce inefficiencies.

**Energy Management Control Systems (EMCS)** – EMCS provide the ability to control various energy consuming functions so that the energy-using equipment is deployed at only the most efficient times. An example is programmable thermostats with sensors so that work spaces are only heated/cooled when there is actual occupancy. EMCS enable reduction in energy use by improving efficiency.

**Energy Master Planning** – Energy Management Planning is long-range energy supply and infrastructure planning that is guided by the Net Zero Energy goal. The planning process begins by establishing a baseline of current energy usage and a comprehensive planning vision towards Net Zero goals. The integration of alternative or renewable energy sources requires planning as there are many steps to ensure the existing infrastructure will be able to accommodate new sources. Facility managers must also have a good sense of future energy demand such that new or alternative sources are appropriately connected to and supportive of the overall system and support energy security. Energy management plans are needed to justify and support the many individual actions that need to be coordinated to achieve Net Zero Energy.





# Army Net Zero Best Practices



Fort Detrick Central Incinerator (waste to energy capabilities)

**Energy Modeling** – Energy modeling is used to estimate a building's energy requirements. Modeling is accomplished using computer tools that simulate the interaction of building systems to estimate how they impact overall energy performance. The use of energy modeling in the design stage provides insights that can contribute to more effective design decisions to conserve facility energy. For manufacturing locations, energy modeling can create efficiencies in manufacturing processes and product flow.

**Leadership in Energy & Environmental Design (LEED)** – The United States Green Building Council's LEED is an evaluation criteria program that helps to drive sustainable design and development, of which reduced energy use is one of the major focus areas. Installations can pursue energy use reduction credits through implementation of this program for new construction and major renovations. Designing buildings using LEED helps to reduce energy use throughout the life cycle of the building by use of improved construction materials, altering building orientation, and installing more efficient equipment, for example.

**Meter Data Management System (MDMS)** – Collecting and analyzing energy use through automated systems such as the Army MDMS provides an understanding of the baseline and allows progress to be measured. Data from these systems allow installations to determine facility energy intensity and identify areas on which to focus solutions. Remotely monitoring buildings systems allow staff to identify service issues prior to emergency situations and lower energy use for buildings that are not continuously occupied.

## Thermal Building Envelope Analysis

– The thermal building envelope is a control layer around the building which encloses the conditioned spaces and reduces heating and cooling inefficiencies. Infrared thermography is used to assess the integrity of the thermal envelope by identifying thermal breaks due to un-insulated or inadequately insulated envelope components and points of infiltration and exfiltration. Once identified, these areas can be addressed through Sustainment, Restoration and Modernization (SRM) upgrades to support progress to Net Zero Energy.

## Strategies

### Building Envelope Improvements

– Reducing heat transfer through a building's envelope increases its thermal performance and reduces the energy needed to cool or heat the

building. Increased thermal performance can be accomplished through improved wall, roof, door and window insulation, improved window solar heat gain coefficients and techniques to reduce air infiltration. These improvements are often a low-cost action to reduce energy use.

**Building System Retrofits** – Retrofitting building systems such as Heating, Ventilation and Air Conditioning (HVAC) and water heaters to more efficient systems can greatly reduce energy use.

**Consolidation of Offices and Facilities/Closing of Unused Space** – Building systems (e.g. heating, air-conditioning) typically are designed to operate the building under full occupancy conditions. When buildings are under-occupied these systems are cooling and heating space that is not being used which wastes energy. Consolidating staff into full occupancy buildings will allow the building systems in newly created vacant building to be shut off.

**Energy Efficient Lighting/Retrofits** – Retrofit or replacements of existing lamps and ballasts with higher efficiency/low wattage alternatives such as light-emitting diodes (LEDs) reduces the amount of energy needed for building and space lighting.

**Energy (or Resource Efficiency) Managers** – Energy Managers are required positions in Army Department of Public Works (DPW) staff. These dedicated positions have a positive impact on an installations' success at pursuing Net Zero Energy by providing focused attention and dedicated expertise. Energy Managers use the assessment, modeling, and measurement tools to identify management

approaches, changes to equipment or other strategies and then they ensure these are implemented. Trained Energy Managers can help ensure larger Net Zero projects are successfully incorporated into the existing grid or distribution infrastructure.

**Garrison Energy Steering Committee** – Establishing a committee to identify methods of reducing energy usage can be an effective method of achieving Net Zero goals. This group can work together to identify strategies and affect a shift in installation operations and management that result in engaging everyone in the pursuit of Net Zero Energy.

**Renewable Energy Implementation** – In order to achieve Net Zero Energy, renewable sources must eventually meet all of the energy needs of the installation. Effective implementation of renewable energy requires a long-term perspective as new sources are investigated, evaluated, and brought on line. The investigation and implementation of renewable energy is a necessary component of Net Zero Energy.

**Retro/Continuous Commissioning** – Commissioning ensures that building systems such as high-efficiency boilers, chillers, pumps, fan motors, and water heaters operate as designed. This enables the systems to operate under conditions of optimal efficiency reducing the amount of energy needed for operation.

## Outreach, Education and Awareness

Successful implementation of Net Zero requires both top-down command support and bottom-up community support. Members of the installation community will need to make different choices about the energy they consume. Tenant organizations must be aware of the installation goals and support Net Zero actions. To accomplish this, a significant amount of outreach, education and awareness of Net Zero will be needed. Outreach, education and awareness are often low cost Net Zero actions that may be overlooked, but these can often have significant impact or may be essential to support the success of other Net Zero actions. Additionally, developing new partnerships can help installations achieve their Net Zero goals. Examples of outreach, education and awareness strategies that can be leveraged to achieve Net Zero Energy are as follows (in alphabetical order):

**Energy Conservation Public Awareness** – Public awareness programs aimed at changing behaviors have been shown to have productive results. Awareness campaigns seek to instill energy efficiency as a fundamental value. People tend to take energy for granted, and many are unaware of the opportunities

they have to reduce energy use. A public awareness campaign involves developing messages and then communicating these through many different sources of media. Messages are statements that provide the basis for action. The target audience should relate to, believe, and be motivated by the messages. Campaigns can also include workshops, conferences, contests and other types of events or engagement with local communities. Installations have engaged with their neighboring communities through local or regional conferences on Net Zero and sustainability.

**Participation in Design Charrettes** – Net Zero or sustainability staff participation in design or planning charrettes helps to raise awareness of what the installation desires for its new buildings or new infrastructure. Cross-functional teams can help share expertise in support of a common goal, at the same time building positive support networks within the installation.

**Residential Billing Program** – Energy conservation is often achieved by providing financial incentives. Army Residential Communities Initiative (RCI) contractors are implementing mock and live billing to increase resident awareness of and subsequently reduce utility use. Installations have seen up to one-third of homes qualifying for rebates by conserving energy.

## Pilot Programs and New Technologies

Pilot programs and demonstration projects are a potential venue to support efforts toward Net Zero Energy. Before new technologies are deployed widely across an installation they are often demonstrated on a smaller scale through pilot programs and demonstration and validation (Dem/Val) projects. Pilot programs may involve new technologies or working with new partners. The focus is on temporarily implementing a new approach or technology, or leveraging external stakeholders with similar interests, to provide an opportunity to document the full effects of the actions on Net Zero goals before it is more permanently adopted. Examples of technologies that can be leveraged to achieve Net Zero Energy goals are as follows (in alphabetical order):

**Biomass Boilers** – Biomass is often an agricultural or industrial residue that is burned to create heat. Biomass replaces fossil fuel in a boiler to provide a reliable onsite renewable energy source.

**Concentrated Solar Power (CSP)** – This renewable energy technology is being investigated for feasibility at some Net Zero





# Army Net Zero Best Practices

Energy pilot installations. These renewable energy systems use mirrors or lenses to concentrate solar thermal energy which is then used to drive a heat engine to generate electrical power.

**Geothermal Power** – These systems use thermal energy generated and stored in the earth as a generating source for electricity. Several pilot installations are investigating this technology by conducting geothermal investigations.

**Ground Source Heat Pump (GSHP)** – This technology relies on the fact that ground temperatures are more moderate than air temperatures. The GSHP is used to bring this moderate air to the surface to increase the efficiency of space heating/cooling systems. This technology can be a cost effective method of reducing building energy needs, however, the efficiency and cost-effectiveness varies by geographic location requiring demonstration that a site is suitable prior to investment.

**Solar Hot Water** – Solar hot water systems enable thermal energy to be captured reducing the need to use fuel to heat water and the associated costs. Roof-mounted collectors absorb solar heat to heat water. The water is held in a well-insulated storage tank until used.

**Solar Walls** – Solar walls collect solar heat which is used to reduce building heating needs. An exterior wall is heated by solar radiation which absorbs the heat and reradiates it into the buildings, lowering the need for fossil-fueled heating systems.

**Improve Steam Plant Efficiencies** – For some installations, central steam plants may be the best solution as they allow equipment to be sized for optimal efficiency and allow individual units to be dispatched based on operating efficiency thereby reducing energy costs. However, central steam plants have losses during transport from point of generation to point of use. Decentralized plants, which generate the steam near the point of use, allow these losses to be greatly minimized thereby increasing system efficiency. Careful consideration should be given to the best solution that will result in decreased energy use.

**Waste to Energy Systems** – These systems address solid waste disposal while producing energy. These systems harvest waste streams for their energy value and convert them into electricity, gas, or heat.

## Existing Programs and Funds

Many installations have sustainability, energy efficiency, water conservation, recycling, pollution prevention, and green procurement programs in place that they can leverage to advance new Net Zero actions.

Although available resources may be limited in existing programs, installations have direct control over these resources. Installations increase their chances to access existing programs and funds when they can show that Net Zero actions and projects can lead to cost savings, energy efficiencies and positive mission impact. Examples of existing programs and funding sources that can be leveraged to achieve Net Zero Energy are (in alphabetical order):

**Energy Conservation Investment Program (ECIP)** – ECIP is part of the Military Construction (MILCON) program and is designated for projects that save energy or reduce energy costs. Funding is awarded by the Office of the Deputy Under Secretary of Defense (OSD) on a by-project basis and awards are allocated based on a combination of the highest savings to investment ratio (SIR) and the priorities emphasized by the Energy Policy Act of 2005, Executive Order (EO) 13423, and the Energy Independence and Security Act of 2007. This funding is an important existing program that can be leveraged in support of Net Zero Energy.

**Energy Savings Performance Contract (ESPC)** – Through the ESPC, installations can partner with an Energy Services Company (ESCO) wherein the ESCO conducts an energy audit and then identifies and implements energy savings improvements with no upfront costs required by the installations. Payment to the ESCO is based on the energy savings over time.

**Power Purchase Agreement (PPA)** – A PPA is an alternative financing mechanism that is a contract between an installation and an onsite energy provider. These long-term contracts can provide price stability and an avenue to develop onsite renewable energy generation with no upfront cost to the Army.

**Utility Energy Savings Contract (UESC)** – Installations can secure third party financing through their utility using a UESC and is considered to be one of the best opportunities in the Federal government to retrofit the energy systems needed to achieve energy management goals.

**Utilities Modernization Program (UMP)** – The UMP is for utility systems that are exempt from privatization. The goal of this program is to assist installations in raising their utility performance to a level higher than original performance or design level. The program focuses on central energy plants, thermal distribution systems and water distribution systems.

# Energy · Water · Waste

Fort Hunter Liggett Solar Powered Entrance Gate





It's operationally necessary, it's fiscally prudent, and it's mission essential for us to make sure that we have energy security and can perform our primary mission for the United States.

– Honorable Katherine Hammack

---

## Resources

ASA (IE&E) home page:  
[www.army.mil/asaiee](http://www.army.mil/asaiee)

Energy and Sustainability Webpage:  
[www.asaie.army.mil/Public/ES](http://www.asaie.army.mil/Public/ES)

Army Energy Program Net Zero Vision:  
<http://www.asaie.army.mil/Public/ES/netzero/index.html>



## **APPENDIX B**

### **Text Version of the Net Zero Energy Best Practices**



Energy Textf.docx

## **Army Net Zero Best Practices**

### **Net Zero Energy**

Net Zero Energy involves reducing overall energy use, maximizing efficiency, implementing energy recovery and cogeneration opportunities, and then offsetting the remaining demand with the production of renewable energy from on-site sources, such that the Net Zero Energy installation produces as much renewable energy as it uses over the course of a year.

**THE ARMY'S NET ZERO INITIATIVE:** Net Zero is a strategy for sustainably managing energy, water, and solid waste programs on Army installations in a way that ensures the Army of tomorrow has the same access to energy, water, land and natural resources as today's Army. Net Zero installations will reduce energy and water usage and solid waste generation, exceeding goals set by Executive Orders, Department of Defense (DoD) Directives and Army Policies, where fiscally responsible. The journey towards Net Zero will provide greater energy and water security and increase operational flexibility.

### **Introduction**

To date, the Army has made substantial progress in the areas of Net Zero Energy, Water, and Waste. A number of federal mandates, rising fuel costs, over-reliance on fragile commercial power grids, aging water and wastewater distribution systems coupled with the risk of compliance penalties have challenged the Army to step up and lead by example with its Net Zero Initiative. The Army rose to this challenge with the Net Zero Pilot Installation Initiative, which has allowed the Army to identify best practices and lessons learned that can be used to guide all installations in achieving Net Zero goals. Capturing lessons learned and incorporating best practices in installation operations and management is a crucial step in institutionalizing Net Zero across the Army enterprise. This document summarizes best practices for implementing Net Zero Energy which can decrease costs, improve energy security and increase operational capabilities and resiliency. Best practices are organized into four main areas: 1) Management Tools and Strategies; 2) Outreach, Education and Awareness; 3) Pilot Programs and New Technologies; and, 4) Existing Programs and Funds. While this document is specific to energy, some of the listed best practices are programs, policies, and strategies that can also be applied to Net Zero Water and Waste, as well as integrated efforts to align Net Zero Energy, Water and Waste efforts.

### **Management Tools and Strategies**

Management tools include software and data systems that enable improved energy management of facilities. The tools allow energy use to be determined, monitored, and analyzed to facilitate



the identification of reduction and efficiency opportunities. Management strategies are available that focus on commissioning, retrofits and ongoing activities within buildings to enable more efficient use of energy. The following lists management tools first and then strategies that have been tried and proven as a best practice in the pursuit of Net Zero Energy (in alphabetical order):

### *Tools*

- Energy Assessment Tools – Assessment tools such as the National Renewable Energy Laboratory's (NREL) *simuwatt* can estimate energy usage with better accuracy and faster results than with a traditional on-site audit. Energy assessment tools can quickly pinpoint energy losses in order to isolate and reduce inefficiencies.
- Energy Management Control Systems (EMCS) – EMCS provide the ability to control various energy consuming functions so that the energy-using equipment is deployed at only the most efficient times. An example is programmable thermostats with sensors so that work spaces are only heated/cooled when there is actual occupancy. EMCS enable reduction in energy use by improving efficiency.
- Energy Master Planning – Energy Management Planning is long-range energy supply and infrastructure planning that is guided by the Net Zero Energy goal. The planning process begins by establishing a baseline of current energy usage and a comprehensive planning vision towards Net Zero goals. The integration of alternative or renewable energy sources requires planning as there are many steps to ensure the existing infrastructure will be able to accommodate new sources. Facility managers must also have a good sense of future energy demand such that new or alternative sources are appropriately connected to and supportive of the overall system and support energy security. Energy management plans are needed to justify and support the many individual actions that need to be coordinated to achieve Net Zero Energy.
- Energy Modeling - Energy modeling is used to estimate a building's energy requirements. Modeling is accomplished using computer tools that simulate the interaction of building systems to estimate how they impact overall energy performance. The use of energy modeling in the design stage provides insights that can contribute to more effective design decisions to conserve facility energy. For manufacturing locations, energy modeling can create efficiencies in manufacturing processes and product flow.
- Leadership in Energy & Environmental Design (LEED) – The United States Green Building Council's LEED is an evaluation criteria program that helps to drive sustainable design and development, of which reduced energy use is one of the major focus areas. Installations can pursue energy use reduction credits through implementation of this program for new construction and major renovations. Designing buildings using LEED helps to reduce energy use throughout the life cycle of the building by use of improved construction materials, altering building orientation, and installing more efficient equipment, for example.



- Meter Data Management System (MDMS) - Collecting and analyzing energy use through automated systems such as the Army MDMS provides an understanding of the baseline and allows progress to be measured. Data from these systems allow installations to determine facility energy intensity and identify areas on which to focus solutions. Remotely monitoring buildings systems allow staff to identify service issues prior to emergency situations and lower energy use for buildings that are not continuously occupied.
- Thermal Building Envelope Analysis - The thermal building envelope is a control layer around the building which encloses the conditioned spaces and reduces heating and cooling inefficiencies. Infrared thermography is used to assess the integrity of the thermal envelope by identifying thermal breaks due to un-insulated or inadequately insulated envelope components and points of infiltration and exfiltration. Once identified, these areas can be addressed through Sustainment, Restoration and Modernization (SRM) upgrades to support progress to Net Zero Energy.

### *Strategies*

- Building Envelope Improvements – Reducing heat transfer through a building's envelope increases its thermal performance and reduces the energy needed to cool or heat the building. Increased thermal performance can be accomplished through improved wall, roof, door and window insulation, improved window solar heat gain coefficients and techniques to reduce air infiltration. These improvements are often a low-cost action to reduce energy use.
- Building System Retrofits - Retrofitting building systems such as Heating, Ventilation and Air Conditioning (HVAC) and water heaters to more efficient systems can greatly reduce energy use.
- Consolidation of Offices and Facilities/Closing of Unused Space - Building systems (e.g. heating, air-conditioning) typically are designed to operate the building under full occupancy conditions. When buildings are under-occupied these systems are cooling and heating space that is not being used which wastes energy. Consolidating staff into full occupancy buildings will allow the building systems in newly created vacant building to be shut off.
- Energy Efficient Lighting/Retrofits - Retrofit or replacements of existing lamps and ballasts with higher efficiency/low wattage alternatives such as light-emitting diodes (LEDs) reduces the amount of energy needed for building and space lighting.
- Energy (or Resource Efficiency) Managers - Energy Managers are required positions in Army Department of Public Works (DPW) staff. These dedicated positions have a positive impact on an installations' success at pursuing Net Zero Energy by providing focused attention and dedicated expertise. Energy Managers use the assessment, modeling, and measurement tools to identify management approaches, changes to equipment or other strategies and then they ensure these are implemented. Trained

Energy Managers can help ensure larger Net Zero projects are successfully incorporated into the existing grid or distribution infrastructure.

- Garrison Energy Steering Committee – Establishing a committee to identify methods of reducing energy usage can be an effective method of achieving Net Zero goals. This group can work together to identify strategies and affect a shift in installation operations and management that result in engaging everyone in the pursuit of Net Zero Energy.
- Renewable Energy Implementation – In order to achieve Net Zero Energy, renewable sources must eventually meet all of the energy needs of the installation. Effective implementation of renewable energy requires a long-term perspective as new sources are investigated, evaluated, and brought on line. The investigation and implementation of renewable energy is a necessary component of Net Zero Energy.
- Retro/Continuous Commissioning - Commissioning ensures that building systems such as high-efficiency boilers, chillers, pumps, fan motors, and water heaters operate as designed. This enables the systems to operate under conditions of optimal efficiency reducing the amount of energy needed for operation.

### **Outreach, Education and Awareness**

Successful implementation of Net Zero requires both top-down command support and bottom-up community support. Members of the installation community will need to make different choices about the energy they consume. Tenant organizations must be aware of the installation goals and support Net Zero actions. To accomplish this, a significant amount of outreach, education and awareness of Net Zero will be needed. Outreach, education and awareness are often low cost Net Zero actions that may be overlooked, but these can often have significant impact or may be essential to support the success of other Net Zero actions. Additionally, developing new partnerships can help installations achieve their Net Zero goals. Examples of outreach, education and awareness strategies that can be leveraged to achieve Net Zero Energy are as follows (in alphabetical order):

- Energy Conservation Public Awareness - Public awareness programs aimed at changing behaviors have been shown to have productive results. Awareness campaigns seek to instill energy efficiency as a fundamental value. People tend to take energy for granted, and many are unaware of the opportunities they have to reduce energy use. A public awareness campaign involves developing messages and then communicating these through many different sources of media. Messages are statements that provide the basis for action. The target audience should relate to, believe, and be motivated by the messages. Campaigns can also include workshops, conferences, contests and other types of events or engagement with local communities. Installations have engaged with their neighboring communities through local or regional conferences on Net Zero and sustainability.
- Participation in Design Charrettes - Net Zero or sustainability staff participation in design or planning charrettes helps to raise awareness of what the installation desires for its new

buildings or new infrastructure. Cross-functional teams can help share expertise in support of a common goal, at the same time building positive support networks within the installation.

- Residential Billing Program - Energy conservation is often achieved by providing financial incentives. Army Residential Communities Initiative (RCI) contractors are implementing mock and live billing to increase resident awareness of and subsequently reduce utility use. Installations have seen up to one-third of homes qualifying for rebates by conserving energy.

### **Pilot Programs and New Technologies**

Pilot programs and demonstration projects are a potential venue to support efforts toward Net Zero Energy. Before new technologies are deployed widely across an installation they are often demonstrated on a smaller scale through pilot programs and demonstration and validation (Dem/Val) projects. Pilot programs may involve new technologies or working with new partners. The focus is on temporarily implementing a new approach or technology, or leveraging external stakeholders with similar interests, to provide an opportunity to document the full effects of the actions on Net Zero goals before it is more permanently adopted. Examples of technologies that can be leveraged to achieve Net Zero Energy goals are as follows (in alphabetical order):

- Biomass Boilers – Biomass is often an agricultural or industrial residue that is burned to create heat. Biomass replaces fossil fuel in a boiler to provide a reliable onsite renewable energy source.
- Concentrated Solar Power (CSP) - This renewable energy technology is being investigated for feasibility at some Net Zero Energy pilot installations. These renewable energy systems use mirrors or lenses to concentrate solar thermal energy which is then used to drive a heat engine to generate electrical power.
- Geothermal Power - These systems use thermal energy generated and stored in the earth as a generating source for electricity. Several pilot installations are investigating this technology by conducting geothermal investigations.
- Ground Source Heat Pump (GSHP) – This technology relies on the fact that ground temperatures are more moderate than air temperatures. The GSHP is used to bring this moderate air to the surface to increase the efficiency of space heating/cooling systems. This technology can be a cost effective method of reducing building energy needs, however, the efficiency and cost-effectiveness varies by geographic location requiring demonstration that a site is suitable prior to investment.
- Solar Hot Water – Solar hot water systems enable thermal energy to be captured reducing the need to use fuel to heat water and the associated costs. Roof-mounted collectors absorb solar heat to heat water. The water is held in a well-insulated storage tank until used.

- Solar Walls – Solar walls collect solar heat which is used to reduce building heating needs. An exterior wall is heated by solar radiation which absorbs the heat and reradiates it into the buildings, lowering the need for fossil-fueled heating systems.
- Improve Steam Plant Efficiencies – For some installations, central steam plants may be the best solution as they allow equipment to be sized for optimal efficiency and allow individual units to be dispatched based on operating efficiency thereby reducing energy costs. However, central steam plants have losses during transport from point of generation to point of use. Decentralized plants, which generate the steam near the point of use, allow these losses to be greatly minimized thereby increasing system efficiency. Careful consideration should be given to the best solution that will result in decreased energy use.
- Waste to Energy Systems - These systems address solid waste disposal while producing energy. These systems harvest waste streams for their energy value and convert them into electricity, gas, or heat.

### **Existing Programs and Funds**

Many installations have sustainability, energy efficiency, water conservation, recycling, pollution prevention, and green procurement programs in place that they can leverage to advance new Net Zero actions. Although available resources may be limited in existing programs, installations have direct control over these resources. Installations increase their chances to access existing programs and funds when they can show that Net Zero actions and projects can lead to cost savings, energy efficiencies and positive mission impact. Examples of existing programs and funding sources that can be leveraged to achieve Net Zero Energy are (in alphabetical order):

- Energy Conservation Investment Program (ECIP) – ECIP is part of the Military Construction (MILCON) program and is designated for projects that save energy or reduce energy costs. Funding is awarded by the Office of the Deputy Under Secretary of Defense (OSD) on a by-project basis and awards are allocated based on a combination of the highest savings to investment ratio (SIR) and the priorities emphasized by the Energy Policy Act of 2005, Executive Order (EO) 13423, and the Energy Independence and Security Act of 2007. This funding is an important existing program that can be leveraged in support of Net Zero Energy.
- Energy Savings Performance Contract (ESPC) – Through the ESPC, installations can partner with an Energy Services Company (ESCO) wherein the ESCO conducts an energy audit and then identifies and implements energy savings improvements with no up-front costs required by the installations. Payment to the ESCO is based on the energy savings over time.
- Power Purchase Agreement (PPA) – A PPA is an alternative financing mechanism that is a contract between an installation and an onsite energy provider. These long-term

contracts can provide price stability and an avenue to develop onsite renewable energy generation with no upfront cost to the Army.

- Utility Energy Savings Contract (UESC) – Installations can secure third party financing through their utility using a UESC and is considered to be one of the best opportunities in the Federal government to retrofit the energy systems needed to achieve energy management goals.
- Utilities Modernization Program (UMP) - The UMP is for utility systems that are exempt from privatization. The goal of this program is to assist installations in raising their utility performance to a level higher than original performance or design level. The program focuses on central energy plants, thermal distribution systems and water distribution systems.

Back Cover Quote:

*“It’s operationally necessary, it’s fiscally prudent, and it’s mission essential for us to make sure that we have energy security and can perform our primary mission for the United States.”*

Honorable Katherine Hammack.